CHAPTER 10 - STRIPPING INSULATION FROM CONDUCTORS AND CABLE

10.1 Stripping Round Conductors

Insulated wires shall be prepared in accordance with the following requirements:

1. **Insulation Removal**. Stripping tools, used to remove conductor insulation shall be of the correct size and in correct adjustment and/or calibration. The stripping tools shall be in compliance with paragraph 6.6.1.

2. **Damage to Insulation**. After removal of the insulation segment, the remaining conductor insulation shall not exhibit any damage such as nicks, cuts, crushing, or charring. Conductors with damaged insulation shall not be used. Scuffing from mechanical stripping or slight discoloration from thermal stripping is acceptable.

3. **Damage to Conductors**. After removal of the conductor insulation, the conductor shall not be nicked, cut, or scraped to the point that base metal is exposed. Conductors that were reduced in the cross-sectional area shall not be used.

4. **Wire Lay**. The lay of wire strands shall be restored as nearly as possible to the original lay if disturbed. The conductor shall be cleaned following restoration to the original lay.

5. **Tinning of Conductors for Solder Cups**. The portion of stranded wires that will eventually become a part of the finished solder connection shall be coated with tin-lead solder and cleaned prior to attachment. Additional flux may be used. The flux shall be applied so that it does not flow under the insulation except for traces carried by solder wicking. Flux shall be removed with cleaning solvent applied so that its flow under the conductor insulation is minimal (by avoiding use of excessive solvent and positioning the conductor so that the gravity keeps the solvent from flowing under the insulation). Flow (wicking) of solder along the conductor is permitted but shall not mask the conductor strands at the termination end of the insulation.

NOTE: ***FOR ADDITIONAL REQUIREMENTS, SEE THE LATEST REVISION OF NASA-STD-8739.3.***

6. **Insulation Irregularity**. Mechanical or thermal stripped insulation irregularity is acceptable if it does not exceed 1/4 of the outside diameter of the wire, including the insulation.

7. **Insulation Clearance**.

   a. Soldered Connections.

      (1) **Minimum Insulation Clearance**. The insulation shall not be imbedded in the solder joint. The contour of the conductor shall not be obscured at the termination end of the insulation.

(2) **Maximum Insulation Clearance**. The insulation clearance shall be less than two wire diameters, including insulation, but in no case shall permit shorting between adjacent non-electrically common conductors. Insulation clearance shall be referenced from the first point of contact of the conductor to the terminal.

b. Crimped Connections.

(1) **Minimum Insulation Clearance**. The minimum insulation clearance for all crimped connections is 0.25mm (0.01in.).

(2) **Maximum Insulation Clearance**. The maximum insulation clearance for conductors 20AWG and smaller is 0.75mm (0.03in.). The maximum insulation clearance for conductors 18AWG and larger is 1.25mm (0.05in.).

10.2 Stripping Jackets Over Shields

Jackets over shields may be stripped by either thermal or mechanical means. Nicked shield strands shall not exceed 10 percent of the total number of strands. There shall be no severed strands.

10.3 Stripping Flat Conductor Cable

Flat conductor cable shall be stripped by mechanical means. Conductors shall not be nicked, gouged, necked down, or severed during stripping. After removal of the insulation segment, the remaining conductor insulation shall not exhibit any damage such as nicks, cuts, or crushing. Scuffing from mechanical stripping is acceptable.

CHAPTER 11 - CABLE SHIELDING AND SHIELD TERMINATION

11.1 General RFI/EMI Practices

Interconnecting cables and harnesses shall be designed and constructed to minimize electromagnetic couplings between wires within the assembly that are sensitive to induced interference. On RF signal cables, both the inner conductor and outer conductor braid shall be electrically continuous. Methods by which program isolation requirements can be achieved are listed in the following text.

1. **Isolation of Signals**. Signals can be isolated by using separate connectors and wire harnesses. When a combination of signals passes through a single connector, wires carrying similar signals can be grouped together and laced separately in the harness.

2. **Wire and Cable Types.** RFI/EMI caused by coupling of external fields can be reduced in harnesses by careful selection of wire types that provide control of radiated fields. Listed in order of increasing control are:

    a. Twisted pairs.
    b. Shielded wires.
    c. Single-braid coaxial cable.
    d. Double-braid coaxial cable.
    e. Triaxial cable.

3. **Overall Shielding of Interconnecting Cable and Harness**. Copper braid is the most effective RF shielding. Copper-clad steel-core wire, woven into a flat braid, is also effective shielding material.

11.2 Shield Termination

Shields shall be terminated using one or more of the following methods:

1. Overall shielding using conductive RFI/EMI backshell adapters.
2. Individual shields using solder sleeves.
3. Individual shields using two-piece crimp rings.
4. Large compression ring grounding or bands.
5. Floating shield.

11.3 Terminating Overall Shielding Using RFI/EMI Adapters

Overall shielding may be terminated to the connector shell through special connector accessories (Figure 11-1). Continuity from the connector, through the adapter, to the shield braid is usually made by screwing threaded parts together to predetermined torque values.

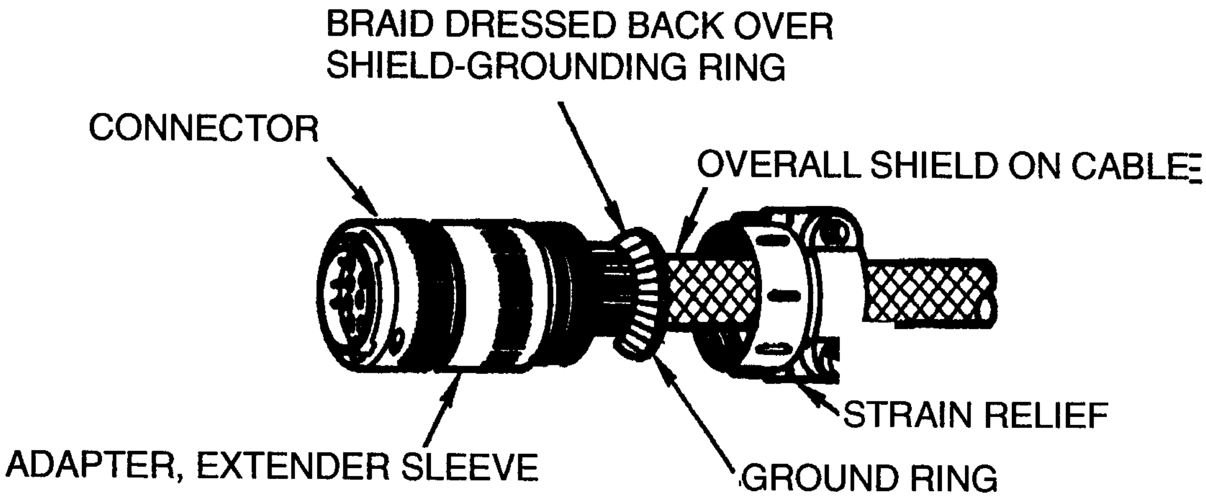


Figure 11-1. Terminating Overall Shield in RFI Adapter (Typical)

11.4 Individual Shield Termination Using Heat Shrinkable Solder Sleeves

An individual shield that is terminated using heat shrinkable solder sleeves to attach grounding wires to the shield braid is shown in Figure 11-2. Heat shrinkable solder sleeves should be installed in accordance with manufacturers' instructions. After shrinking, they shall meet the requirements of 9.10.

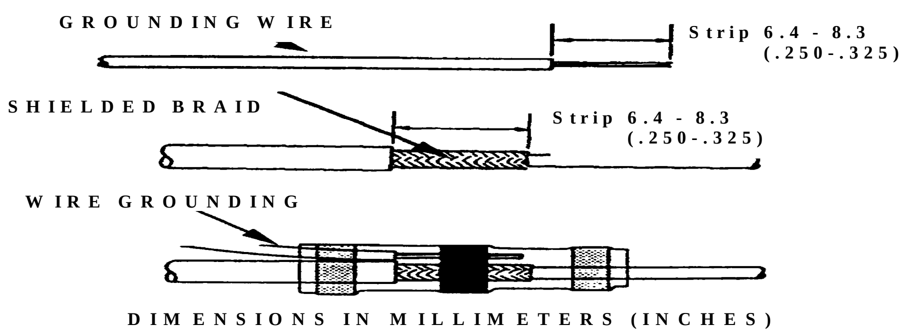


Figure 11-2. Individual Shield Termination Using a Heat Shrinkable Solder Sleeve

11.5 Individual Shield Termination Using Two-Piece Crimp Rings

An individual shield that is terminated using two-piece crimp rings (ferrules) to attach grounding wires to the shield braid is shown in Figure 11-3. The inner crimp ring (ferrule) shall be sized so that any inward distortion caused by crimping will not affect the insulated wires it contains. The end of the grounding wire shall be flush with the outer ferrule, but shall not overhang the inner ferrule. The grounding wire detachment force from the crimped sleeve shall meet the requirements of paragraph 13.7.

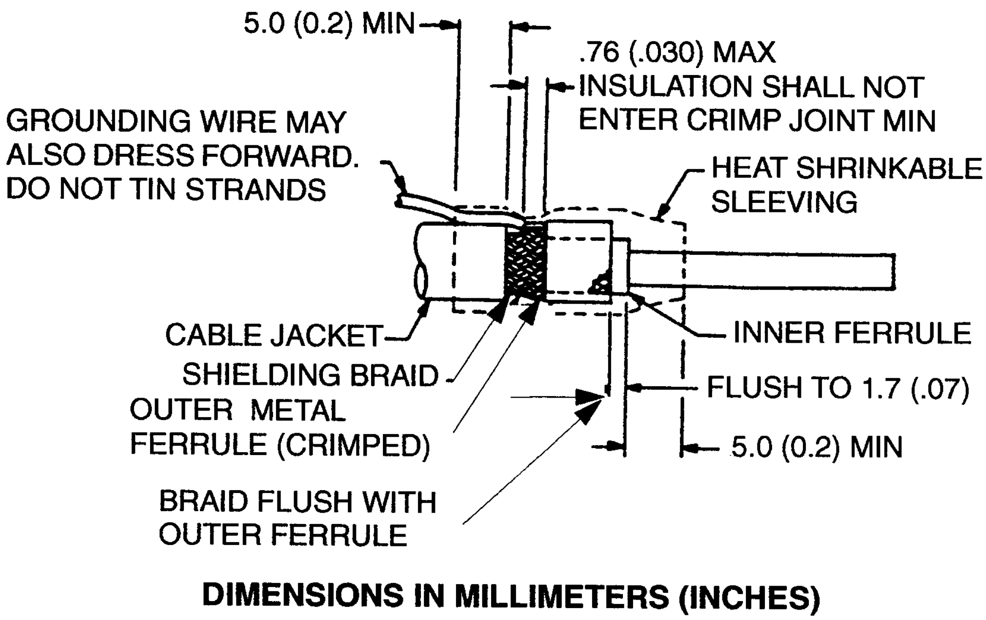


Figure 11-3. Individual Shield Termination Using a Two-Piece Crimp Ring

11.6 Group-Grounding of Individual Shield Terminations

When grounding wires of individual cable shields are grounded to one point, they shall be spliced to a common grounding wire. No more than four conductors plus a drain wire shall be terminated in one splice (see Figure 11-4 and Figure 11-5). For ordinary RFI/EMI protection, the shield shall be terminated within 100mm (4 inches) of the center conductor termination for the x-distance, and the combined length of shield grounding wires shall not exceed 190mm (7.5 inches) for the y-distance. For interference sensitive circuits, preferred lengths are 20 and 115mm (.75 inches and 4.5 inches). See Table 11-1 for the x and y distances. When this does not provide adequate isolation, RFI/EMI connector backshells may be necessary.

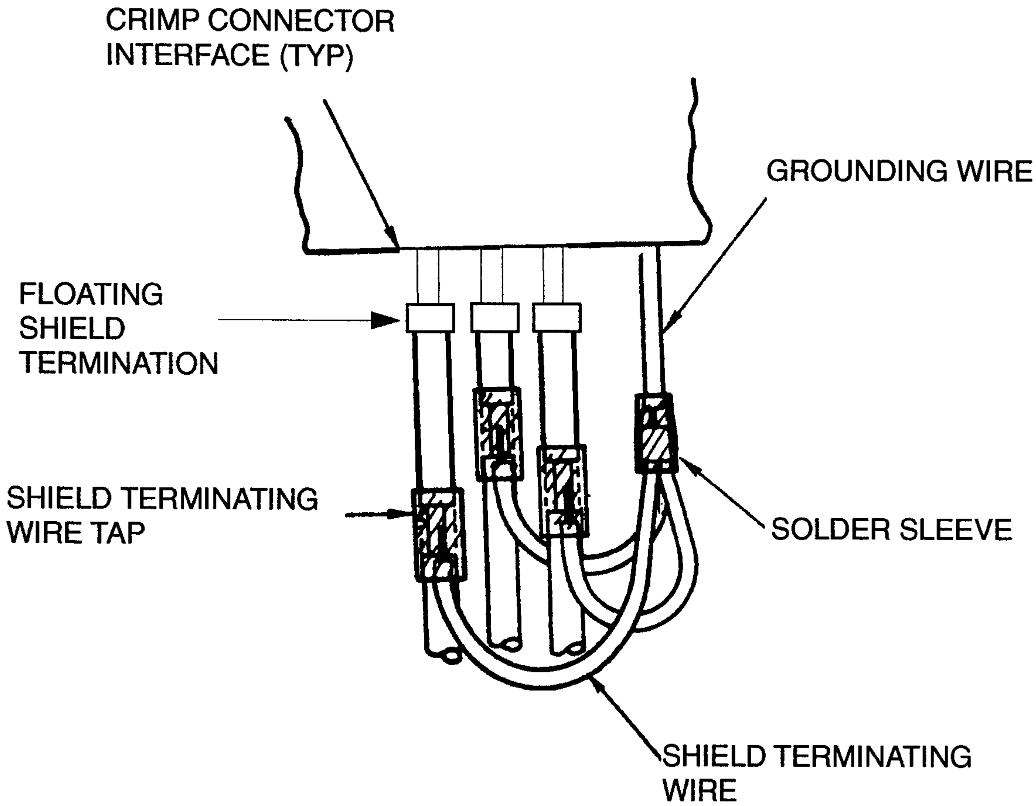


Figure 11-4. Group Grounding of Staggered Shields

Table 11-1. Shield Termination Control for Group Grounding

Name of Circuit	X-Distance Max. mm (Inches)	X-Distance Min. mm (Inches)	Y-Distance Max. mm (Inches)
Interference sensitive	20.0 (0.75)	13 (.50)	115.0 (4.5)
Ordinary interference protection	100.0 (4.0)	13 (.50)	190.0 (7.5)

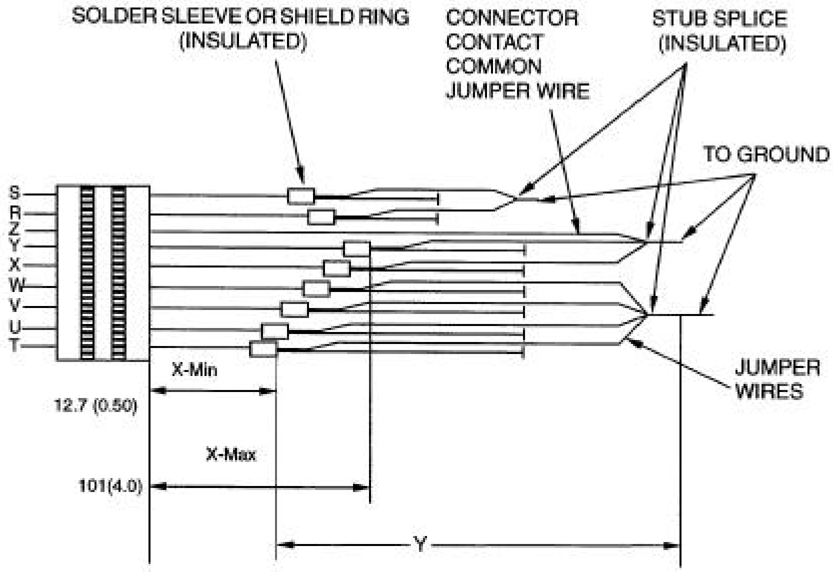


Figure 11-5. Group-Grounding of Individual Shield Terminations

11.7 Large Compression Ring Grounding

Individual shields and overall shields may be grounded using large compression rings. Shields should be dressed across the inner collector ring either forward towards the connector (Figure 11-6B) or backwards away from the connector (Figure 11-6C). Grounding wires shall exit the front or rear of the compression ring as required by design, and shall be formed in accordance with Figure 11-6A. Grounding exiting the side of the compression ring away from the rear of the connector shall be dressed beneath the compression ring when terminating to a connector pin (Figure 11-6D). The outer compression ring shall be crimped securely over the shields and inner collector ring (Figure 11-6E). The grounding wire detachment force from the crimped sleeve shall meet the requirements of paragraph 13.7.

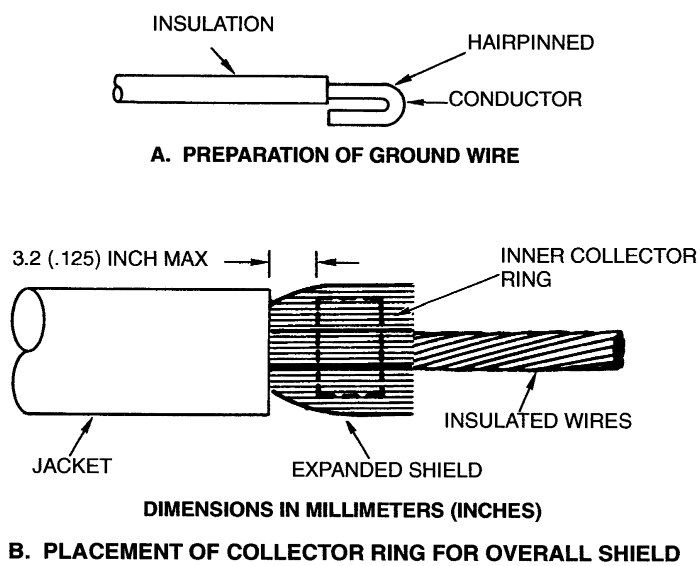
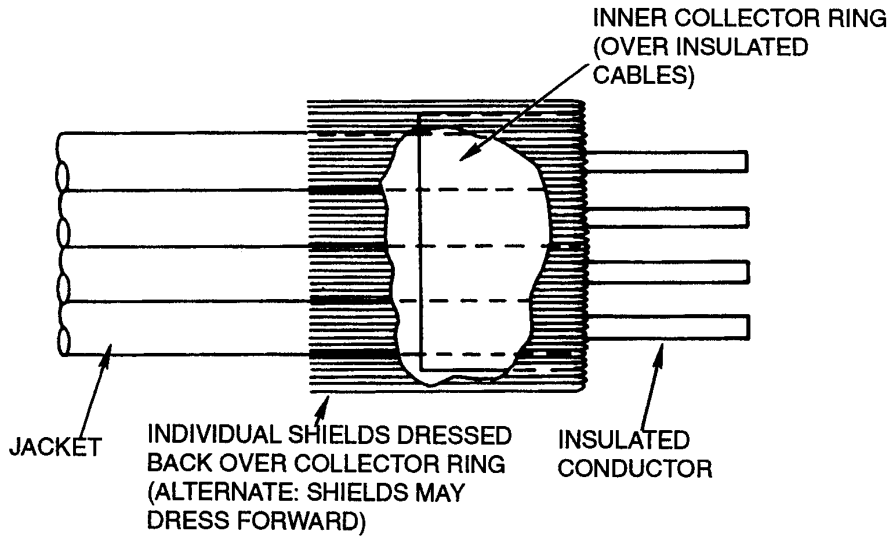
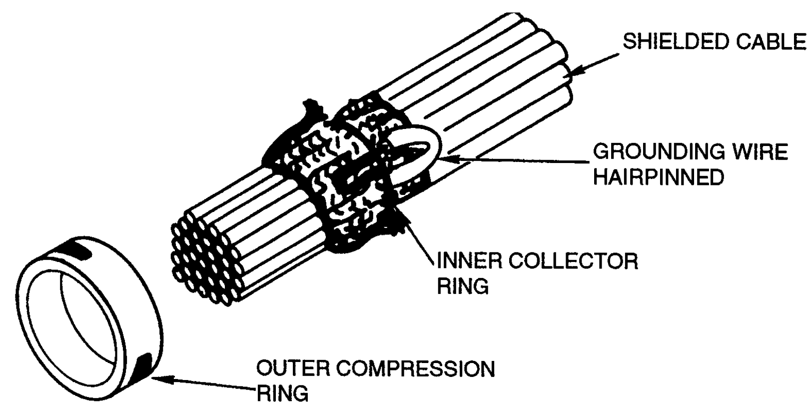


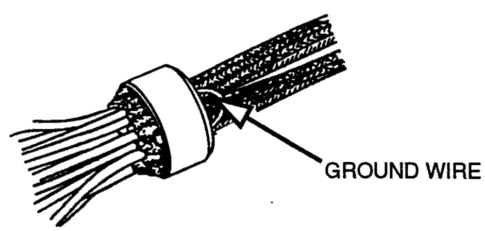
Figure 11-6. Large Compression Ring Grounding (Typical Applications)



C. DRESSING OF INDIVIDUAL SHIELDS OVER COLLECTOR RING



D. PLACEMENT OF HAIRPINNED GROUNDING WIRE PRIOR TO CRIMPING OUTER COMPRESSION RING



E. ASSEMBLY WITH CRIMPED OUTER COMPRESSION RING

Figure 11-6. (continued)

11.8 Floating Shield Terminations

The outer jacket shall be trimmed to expose the shielding braid. The braid shall be folded back over the outer jacket as illustrated in Figure 11-7. Combing the braid is optional. Heat-shrinkable sleeving shall be installed over the trim point.

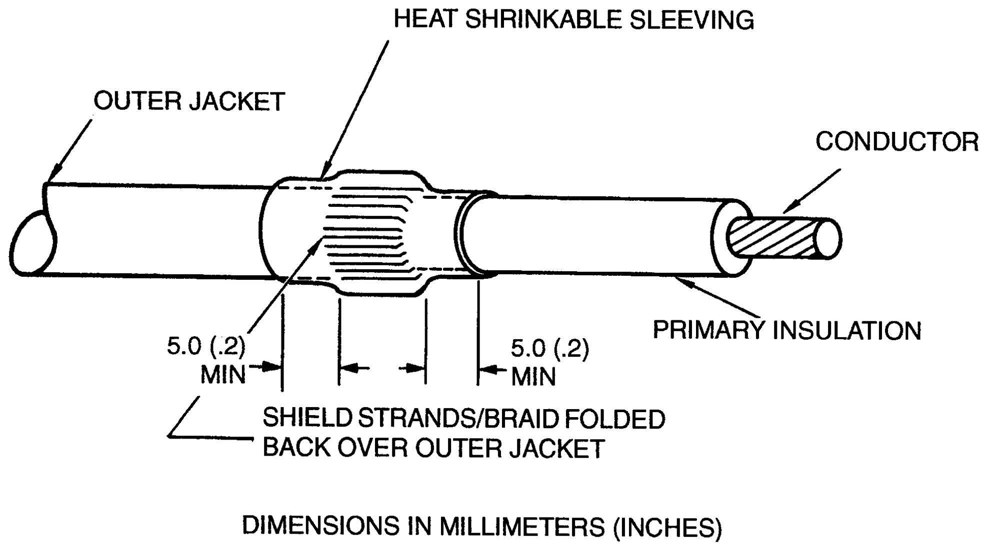


Figure 11-7. Floating Shield Termination

11.9 Unshielded Wire Exposure and Total Length of Grounding Wires

Exposed wire beyond a shield termination is subject to induced RFI/EMI interference. Any excessive length of grounding wire may act as an antenna in picking up interference. Distances to terminations and maximum lengths of grounding wires attached directly to an individual shield are given in Table 11-2 and illustrated in Figure 11-8. Shield terminations shall be staggered behind the connector/accessory 13mm (0.5 inch) minimum and 100mm (4 inches) maximum to assure minimum buildup of the wire bundle diameter in the shield termination area (see Figure 11-5).

Table 11-2. Shield Termination Control (Refer to Figure 8-8)

Nature of Circuit	X-Distance Recommended Max Length mm (Inches)	Y-Distance mm (Inches)
Interference sensitive1/	20 (0.75)	40 (1.5)
Ordinary interference protection	100 (4.0)	150 (6.0)

1/ It may be necessary to use conductive adapter backshells that provide full isolation to secure better RFI/EMI protection for extremely sensitive circuits.

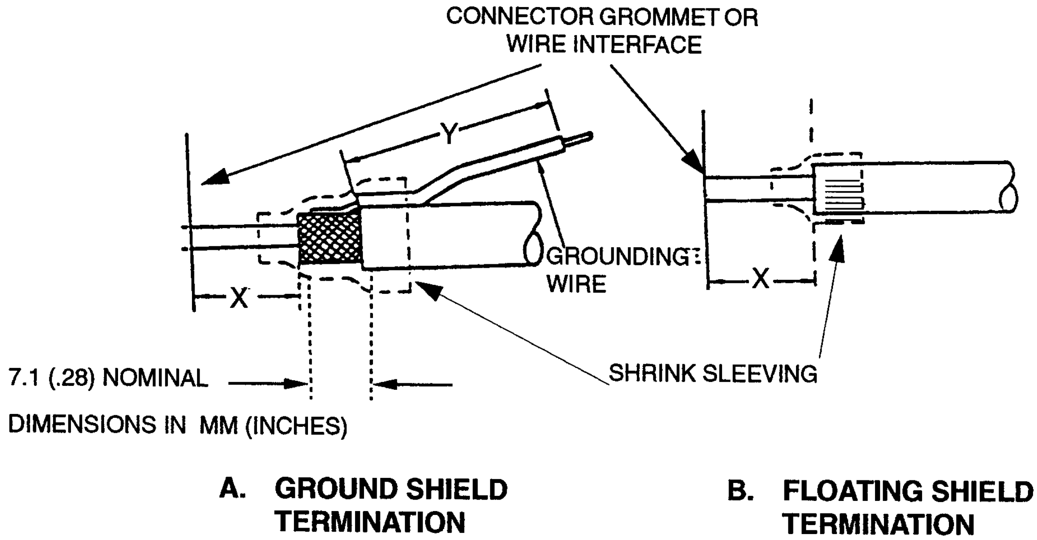


Figure 11-8. Conductor Exposure for Individual Shield Termination Types

CHAPTER 12 - CRIMP CONNECTIONS

12.1 General

1. Crimped connections shall be inspected 100 percent in order to verify compliance with this standard.

2. The tools and equipment used to make crimped connections shall meet the requirements listed in Chapter 6.

3. Insulation gaps shall be as specified in paragraph 10.1-7.

12.2 Examination of Crimp Contact

For manual crimping operations prior to wire insertion, the assembler shall examine the crimp contacts. Contacts that show the following conditions shall not be used.

1. Cracks in the plating or base metal.

2. Tarnishing or discoloration of the plating.

3. Plating removal or flaking.

4. Out-of-roundness of the wire well entrance.

5. Exposed base metal.

12.3 Process Controls

1. Tool and Equipment Control

   a. **Full-Cycle Ratcheting**. Crimp tools shall contain a full-cycle ratcheting mechanism which shall prevent the indenters from releasing before the crimp cycle has been completed.

   b. **Number of Indenters**. Each crimp tool shall have a minimum of four indenter blades (preferably double-indenter blades).

   c. **Calibration Adjustments**. The calibration adjustments shall be accessible only when the tool is disassembled. These adjustments shall be made only by the manufacturer of the tool or by a calibration laboratory.

   d. **Sealing of Adjustable Tools**. All adjustable crimp tools shall be set, sealed or locked, and verified prior to use.

2. Examination of Crimp Tools. All tools used in production.

a. Nonadjustable tools. If the tool is broken or damaged, it shall be removed from service.

b. Tools with a sealed setting and sealed locator or position. If the tool is broken or damaged, or if the seal is broken, the tool shall be removed from service.

c. Records of examination shall be maintained for hand tools

3. **Allowable Contact-Conductor Combinations.** The contact-conductor combinations shall be in accordance with manufacturer's recommendations. Contacts or conductors shall not be modified.

4. Integrity of Crimped Connections

a. **Test Interval**. The crimp tools and each contact-conductor combination to be used in a production run shall be tested at the start and at the end of each work shift or production run, whichever is shorter. Test results shall be recorded and maintained for each crimp tool and contact-conductor combination.

b. **Number of Test Samples**. A minimum of three test samples shall be prepared for each crimp tool and crimp-contact-conductor combination, at the intervals specified in 12.3-4.a.

c. **Test Method**. The crimp contacts shall be placed in a tensile-testing device with appropriate fixtures, and sufficient force shall be applied to pull the wire out of the assembly or to break the wire or crimped item. The head travel speed of the tensile device shall be 25.4 $\pm$ 6.3 mm (1.0 $\pm$ .25 in) per minute. The holding surfaces of the tensile device clamp may be serrated to provide sufficient gripping and holding ability.

d. **Required Crimp Strength**. The tensile strength of the crimp test sample connections shall be in accordance with Table 12-1. For those contact-conductor crimp connections not contained in Table 12-1, the tensile strength of the crimp connection shall be no less than 60 percent of the tensile strength of the wire.

e. **Failure Categories**. After pulling, the test specimens shall be examined under a microscope to determine the method of conductor failure. Crimp joint tensile failures will fall into one of the categories shown in Figure 12-1. The crimp tool setting which produces the maximum number of fray breaks and breaks outside the contact shall be used for assembly (see Note in Figure 12-1). If multiple settings provide identical tensile strengths for a crimp joint, the setting selected shall be the one that provides more wire breaks than wire pull-outs.

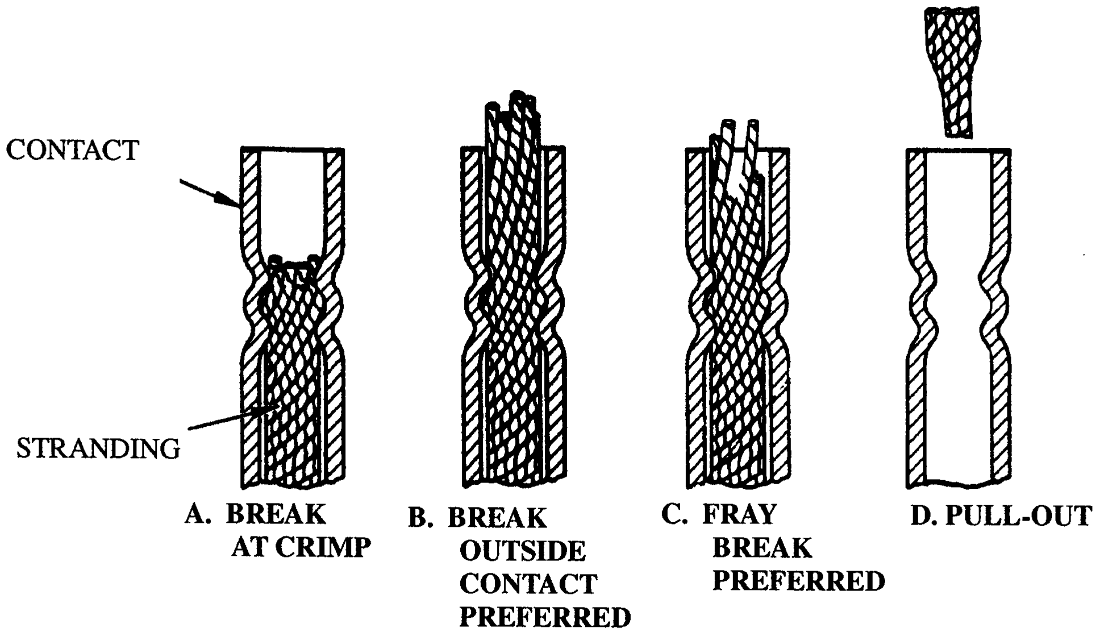
f. **Examination of Test Samples**. Each individual test sample shall be inspected to the requirements of this document and the observations recorded and maintained.

Table 12-1. Crimp Tensile Strength 1/

Wire Barrel Size	Copper, Conductor Size, AWG 2/	Tensile Strength, Newtons (Pounds), Minimum
22M & 24	28 26 24	22 (5) 36 (8) 36 (8)
22D & 22	28 26 24 22	22 (5) 36 (8) 36 (8) 57 (13)
20	24 22 20	36 (8) 57 (13) 92 (21)
16	20 18 16	92 (21) 142 (32) 183(41)
12	14 12	290 (65) 459 (103)
10	10	707 (159)
8	8	1281 (288)

1/ For contact-conductor combinations not listed in the table, the requirements of 12.4.3.d shall apply.

2/ Refers to copper and high strength copper alloy stranded conductors.



<u>NOTE:</u> ***ALL CATEGORIES ARE ACCEPTABLE IF SEPARATION OCCURS ABOVE MINIMUM TENSILE STRENGTH PER 12.3.4.d.***

<u>NOTE:</u> ***BREAKS AT THE ENTRANCE OF THE CONTACT WIRE BARREL, CAUSED BY CONDUCTOR CUTTING BECAUSE THE CONTACT IS NOT HELD SQUARELY IN THE TESTER JAWS, SHALL NOT BE PREFERRED BREAKS.***

Figure 12-1. Crimp Joint Tensile Failure Categories